The Development of Detector Alignment Monitoring system for the ALICE ITS

J. Fujita[1], M. Cherney[1], Y. Gorbunov[1], R. Thomen[1], T. Humanic[2], B. Nilsen[2], J. Scheley[2], D. Trusdale[2]

1 Creighton University, Omaha, Nebraska; 2 Ohio State University, Columbus, OH

Abstract

A real-time detector alignment monitoring system has been developed by using commodity USB cameras, spherical mirrors, and laser beams introduced via a single mode fiber. An innovative control and online analysis software has been developed by using the OpenCV (Open Computer Vision) library & PVSS (Prozessvisualisierungs- und Steuerungssystem). This system is being installed in the ALICE detector to monitor the position of ALICE's Inner Tracking System subdetector. The operational principle and software implementation will be described.

Introduction

ALICE (A Large Ion Collider Experiment)

- One of the detectors at the Large Hadron Collider at CERN.
- Optimized for heavy ion collisions.

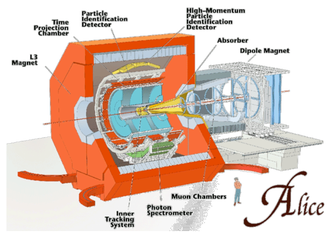

Figure 1: the ALICE detector

ITS (Inner Tracker System)

- Detector in ALICE which is nearest the collision.
- Six different layers of silicon detectors.
- Designed to track particles with momentum lower than 100 MeV/c.
- Designed to improve the angular & momentum resolution of higher than 100 MeV/c particles.

ITSAMS (Inner Tracker System Alignment Monitoring System)

- ITSAMS monitors the position of the ITS in relation to the TPC.
- Insures where the particle track from the ITS meets the track from the same particle in the TPC.
- Must be high precision, small, low thermal output, low weight, relatively high dynamic range, and low cost.

Hardware

- Consists of four units. Each unit consists of a diode laser, a spherical mirror, and a camera.

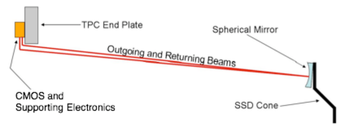

Figure 2: the conceptual diagram of the ITSAMS.

- The diode laser and the camera are mounted on the TPC end plate. The spherical mirror is mounted on the SSD cone.

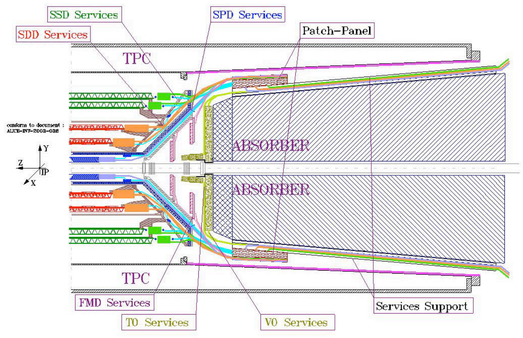

Figure 3: A cross section view of the ITS, showing the layers of the ITS, the support cones, cabling and other services and other detectors.

- High precision monitoring of the relative motion of various strategic points on and around the ITS.
- Inexpensive and physically small.
- The use of passive components on the ITS limits grounding and thermal issues.
- Requires power only at the TPC locations.
- The camera used are ordinary inexpensive USB webcams (Rocketfish Model RF-NBCAM).
- Data is transmitted using USB 2.0 standard. USB-optical fiber bridge and USB-CAT5 extender are used to over come the transmission distance limitation.

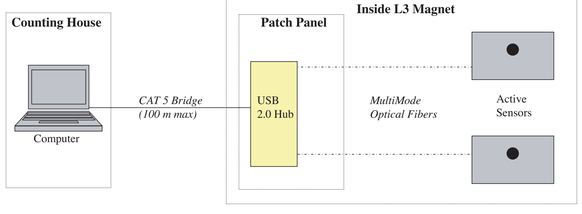

Figure 4: A conceptual drawing of the data path for ITSAMS.

Software

- Image analysis software is written in C++, utilizing various functions in OpenCV
- Cross-platform (currently runs on Windows)
- Easier to write a code (image capture code can be written in a few hours hours of work for a beginner)
- PVSS (Prozessvisualisierungs- und Steuerungssystem) by ETM is used for the graphical interface, archiving of data, and alarm.

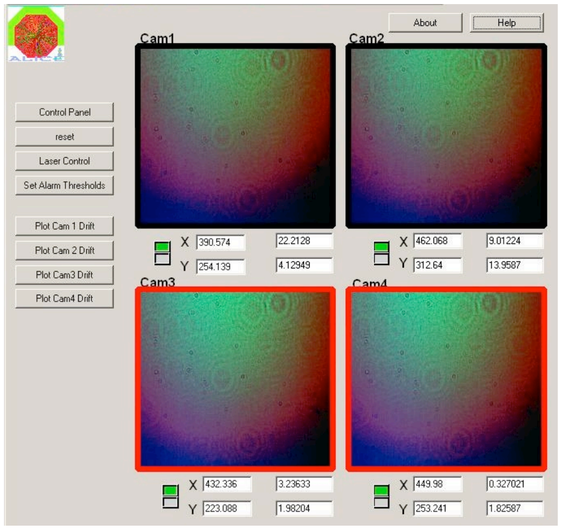

Figure 5: A screenshot of the ITSAMS in PVSS.

Conclusion

- Webcam use provide a more cost effective solution than comparable systems currently available for alignment monitoring.
- Meets all the alignment monitoring requirements for the ALICE ITS.
- OpenCV provides very flexible foundation for the ITSAMS.

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